MODULE AVERAGING STATISTICS FROM THE 2003 CROP

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Abstract

The USDA, AMS, Cotton Program has offered module/trailer (module) averaging on a voluntary basis since 1991. When analyzing the historical results of module averaging for gins across the country, the Cotton Program has concluded that the reproducibility of quality measurements is significantly higher for cotton bales assigned the module average versus the bales' individual readings. This increase in reproducibility indicates less variability in the fiber measurements and more stable classification results. The 2003 crop data continued to support the historical trends.

Module Averaging is advantageous to all users of the Cotton Program classification data. The number of gins participating in module averaging in 2003 rose 14% over 2002 to 210 gins, representing 3,808,979 bales (through December 26, 2003). Analysis of the classification results for these bales show that overall, module averaging proved more advantageous monetarily over individual bale values when using the government loan program as the basis for analysis. In 2002, the Cotton Program implemented a new policy of assigning the module average to all module middle-bale outliers without requiring a review classification (with some exceptions). The Cotton Program implemented this policy after historical data and studies proved that middle-bale outliers, when retested, consistently tend to approach the module average within acceptable testing parameters. This policy excludes the module's first and last bales because they show to be true outliers a higher percentage of the time due to possible overlapping of modules having different fiber properties. This policy also excluded any outliers from a module when they accounted for more than 20% of the total number of bales in the module. These exclusions were implemented to detect rare exceptions to the norm. The Cotton Program also tightened outlier identification tolerances in 2003. Included in this paper are 2003 module averaging statistics, outlier statistics, and comparisons to previous crop years.

Background

Introduction of Module Averaging

Module averaging is a voluntary program offered by the USDA, AMS, Cotton Program at no additional charge to its customers (Earnest, 2003). Module averaging applies only to four HVI quality measurements – micronaire, strength, length, and length uniformity. The Cotton Program tests all bales within a module individually and averages these individual results by quality factor. The resulting average – the "module average" – is then assigned to all of the qualifying bales within the module. Any bales qualifying as true outliers retain their original individual bale measurements.

The Cotton Program first implemented the module-averaging program on a voluntary basis in 1991 in response to a recommendation made by the Secretary of Agriculture's Advisory Committee on Cotton Marketing. Due to strength reproducibility being more variable than other fiber properties, it was the first fiber property offered for module/trailer averaging. The success of the 1991 pilot project resulted in increased industry participation and the expansion of module averaging to include length, length uniformity, and micronaire in addition to strength in 1992. The program expanded briefly in 1993 to include color (Rd), color (+b), and trash (percent area) but was limited to micronaire, strength, length, and length uniformity from 1994 forward because of industry recommendations.

Participation in Module Averaging

Participation in the module-averaging program has been consistent over the years with an average of 204 gins representing approximately 3.4 million bales or 20 percent of the overall crop since 1992 (Table 1.) Gin participation peaked in 1994 at 304 gins and has remained very consistent in recent years at approximately 188 gins.

The Cotton Program handles and grades (classes) module-averaged bale samples in exactly the same manner as traditional samples. Each sample is received, prepared, conditioned, HVI-tested, and classed the same as all non-module averaged bales. The randomly selected checklot samples that classing offices submit to the Quality Assurance (QA) Branch for retest each day include a percentage of the module-averaged samples. The QA Branch does not differentiate between module averaged samples and traditional samples and tests all the same way. In fact, QA does not know prior to testing whether or not a sample represents a bale that was module averaged or retained its individual measurements. After testing, the main computer system calculates comparative statistics for evaluation.

Many gins and producers have expressed apprehension about module averaging, due, in part, to confusion or lack of understanding regarding how the program works. There appears to be confusion regarding the improved data reliability affiliated with module averaging and the inherent value of that increased reliability to all users of the data. There is also some concern

that module averaging may actually be detrimental by reducing premiums or adding discounts to bales when assigning the module average. Although that may be the case in some instances, it is not typical. Rather, history has shown that the tendency is for value to increase slightly for module-averaged bales when looking at the entire amount of cotton submitted from a gin. This, along with increased reliability for each quality, equates to a better data product for the user.

Concept of Module Averaging

The concept of module averaging is that for a given module or trailer, the averages for the measurements of micronaire, strength, length, and length uniformity is a more representative measurement than the individual measurements. In the early 1990s, the problem with high variability in the strength measurement prompted the Secretary of Agriculture's Advisory Committee on Cotton Marketing to initiate a plan to address the problem. The USDA, AMS, Cotton Program (then "Division") performed several extensive studies to investigate the validity of using an average to represent the bales within a module as a possible solution to the variability problem. Studies investigated the degree of blending cotton goes through as it is picked, deposited into a module or trailer, removed from the module or trailer at the gin, and subsequently ginned and baled. The studies concluded that cotton within a module or trailer undergoes significant blending throughout these processes. Therefore, it stood to reason that a bale from within a given module or trailer would be statistically representative of that module or trailer. Subsequent studies continued to support this hypothesis. These studies involved extensive testing of all bales from within given modules and trailers to determine if the variability for a module or trailer was greater than that of an individual bale within the module. The studies showed that the variability was no greater for the module than for the bales within the module. Further, the studies concluded that any one bale from a module would be statistically representative of that module and that when retested several times, the bales' values would always approach the average of the module's values.

A subsequent study followed using "cooperators" from various cotton industry segments, research agencies, and educational institutions whereby cotton was HVI-tested using both the module averaging criteria and the individual bale testing criteria. The results of the cooperators study showed that even with different instruments, testing environments, operators, etc., the module-averaging concept was validated and data obtained from module averaging proved more reproducible than traditional single-bale tests.

Reproducibility of Single Bale vs. Module Bale Testing

Since 1991, the Cotton Program has recorded and analyzed the reproducibility for all quality factors within module-averaged bales using two methods: classing office single test and classing office module average. The single test method compares a single test conducted in the classing office to a double-run (checklot) test performed by the Quality Assurance Branch (QA). The double-run test in QA consists of the same sample being HVI-tested on two different instruments and the results averaged (Gibson, 2003).

The module average method compares the module average value assigned to each bale by the classing office to the double-run test conducted in QA. Table 2 shows the testing tolerances for individual bale testing used in calculating reproducibility for each fiber property. In every case since 1992, the module-average reproducibility for each of the four quality factors has been significantly higher than that of the individual single tests for the bales (Figures 1-4). Higher reproducibility equates to less variability between classing offices and thus, a much more stable and reliable measurement for all data users. Since 1992, the average reproducibility for micronaire when comparing the classing laboratories' module averaging results to QA checklot results is 84% versus 78% for individual testing. For strength, the comparison is 86% compared to 73% for individual testing. For length, the comparison is 89% versus 78% for individual testing. For length uniformity, the comparison is 94% compared to 84% for individual testing (Figure 5).

Looking at the same statistics for the last five years, the results are even more impressive. Since 1999, the reproducibility for micronaire averaged 86% compared to 81% for individual testing. For strength, the comparison is 88% compared to 75%. For length, the comparison is 91% compared to 80%. For length uniformity, the comparison is 95% compared to 86% (Figure 6).

Further, when reviewing the 2003 classing data through December 26, 2003, the results compare favorably to the five-year average. The reproducibility for micronaire averaged 86% compared to 81% for individual testing. For strength, the comparison is 89% compared to 76%. For length, the comparison is 92% compared to 80%. For length uniformity, the comparison is 95% compared to 86% (Figure 7).

Outliers

An "outlier" bale is any bale in a module or trailer average that falls outside of acceptable tolerances for testing as determined by statistical methods. Table 3 shows these acceptable tolerances. After testing concludes for all bales within a module or trailer, the central computer calculates the average for the factors. The computer then compares each of the bale's individual measurements to the average. If the difference exceeds the allowable tolerance for a particular quality factor, the computer removes that bale from the module-average calculation. The fiber properties for the remaining bales are re-averaged and that

value assigned to all of the bales within the module or trailer, with some exceptions. The two primary exceptions are 1) outliers that occur as a first or last bale of a module; and 2) any outliers in the module if the total number of outliers present exceeds 20% of the total number of bales in the module.

Outlier bales represent only a very small percentage of the total amount of bales module averaged each year (Table 4). The Cotton Program has thoroughly analyzed these outliers over the years to determine their primary cause and frequency. There are two types of outliers – first-and-last-bale outliers and middle-bale outliers. In studying outliers that occur either as first or last bales of a module, data supports that a significant percentage of these bales are likely to be true outliers resulting from possible cotton carryover from one module to another. However, in ongoing study of middle bale outliers, the Cotton Program consistently found that a very large majority of these outliers, when retested, closely approach the module average within acceptable testing tolerances. This indicates that the measurement that created the outlier was somehow flawed, an incorrect sample was tested or submitted, or some other anomaly occurred. Prior to 2002, all outliers retained their individual fiber properties in the official classification, regardless of where they occurred. If a customer resubmitted the outlier as a review bale (a sample to be re-classified to verify the original class), the Cotton Program would re-class the sample at no additional cost. However, the customer incurred additional costs for cutting the review sample and for shipping or delivery to the USDA classing office. After continued data analysis of outliers and encouragement from customers who incurred these additional costs, the Cotton Program implemented a new policy in 2002 whereby all middle-bale outliers (except noted exceptions) receive the module average without requiring a review classification. The exception to this rule occurs if a module contains more than 20% outliers of any kind. In this case, all outliers retain their original values. The Cotton Program implemented the "20% rule" to provide an additional safety net in rare occasions when atypically high numbers of outliers occur in larger modules. For example, in a 20-bale module, all outliers would retain their original values if more than four outliers of any kind exist. As previously mentioned, all first-and-last-bale outliers retain their original values in all cases. As before, customers can re-submit any outliers to the Cotton Program for review classification at no additional charge.

The response from the cotton industry regarding the new outlier policy, primarily from the producer and ginning segments, was very positive. Customers were in favor of the new policy to avoid the cost of re-sampling and re-submitting bales, when historically, the review classification went back to the module average. This change is significant to all segments because if all middle-bales outliers retain their original values, it is possible that most will have some incorrect quality data that could cause problems as the bales move through the marketing channels to end users. Assigning the middle-bale outliers the module average value assists greatly in reducing the rare occasions when outliers occur and are released and marketed with incorrect quality information. Although outliers occur very rarely, the Cotton Program considers any of these occurrences as significant.

After the success of implementing the 2002 policy of automatically assigning the module average to middle-bale outliers, and in light of improved testing accuracy in recent years, the Cotton Program decided to tighten the outlier tolerance parameters beginning with the 2003 season. The outlier tolerances were tightened for length from +/- 0.06 to +/- 0.04 inches; micronaire from +/- 0.4 to +/- 0.3 units; strength from +/- 3.3 to +/- 3.0 grams per tex; and length uniformity from +/- 3.0 to +/- 2.0 percent. Given that tightening up the outlier tolerances inherently results in some increase in the total number of outliers encountered, the Cotton Program feels confident that the automatic assignment rule results in better data accuracy for its customers.

The Cotton Program evaluated statistics for the 2002 and 2003 seasons using both the previous outlier tolerances and the tightened tolerances to determine how they compared and to see if any significant decrease in accuracy appeared as a result of the change. These evaluations utilized and studied QA checklot data (Tables 5-8). As with all checklot bales, QA tested each sample two separate times on two different instruments and averaged the results. Evaluations followed comparing the QA results to the classing offices' module-average results and original individual bale values. The tables show that the middle-bale outlier checklots reproduced the module average at a much higher rate than the original individual single-run measurements regardless of the outlier tolerances used (Table 5 and 7). In addition, the 2003 calculations using the new tolerances compared favorably with the 2002 crop when applying the tighter tolerances to that data. Further, both years compared favorably when applying only the old tolerances for comparison purposes. It is apparent that there were more middle-bale outlier checklots using the tighter tolerances, a reflection of more middle-bale outliers present in overall testing. The Cotton Program anticipated this increase due to the tightening of the outlier tolerances. However, the reproducibility associated with the tighter tolerances was virtually unchanged from that of the old tolerances.

In looking at the comparisons further, it is very clear that the reproducibility associated with comparing the QA double-run tests to the outliers' original individual measurements is significantly low for all factors and indicates that the individual measurements, as a whole, tended to reflect testing error. As stated earlier, outliers can occur for a variety of reasons but ongoing Cotton Program studies and analyses indicate that most middle-bale outliers result from testing flaws or correctable error and not typically from cotton variability. The comparative numbers in Table 7 support this reasoning regardless of the outlier tolerances applied.

In studying first-and-last-bale outliers (Table 6 and 8), the numbers indicate that there is volatility in the reproducibility between the QA retests and both the module averaging results and the individual results. This continues to support the Cotton

Program's conviction that first-and-last-bale outliers have a much higher probability of being true outliers than middle-bale outliers and should retain their original testing values.

Value of Module Averaging

Data Product
Since its inception, module averaging has consistently demonstrated its benefits and value. One of the possible reasons for the current level of participation not being higher appears to be the lack of understanding of the benefits of the program to the industry. The primary value of module averaging is in the area of improved fiber testing accuracy. Since the beginning of module averaging in 1991, the data shows laboratory-to-laboratory reproducibility is much higher with module averaging than with traditional single-bale testing. This correlates into much more dependable and reliable data for all users of the classing data. The inherent value is the confidence that the quality measurements of module-averaged bales will always circulate around the mean of that module if retested again and again. It is better for the producers of the cotton, agents and handlers of the cotton, and ultimately the mill or manufacturer that utilizes the fiber to know with the highest certainty available that the HVI measurements of micronaire, strength, length, and length uniformity are stable and reliable. Module averaging provides the certainty that the average of the four factors is a better representation of the whole module than the individual bales within it.

Financial Benefit
The other potential value with module averaging is a financial one. Over the past few years, the Cotton Program has performed analyses to determine the difference in loan value between module-averaged data as compared to the original individual bale data. In 2003, the 210 gins participating in the module averaging program were analyzed. Loan prices for 3,808,486 bales from these gins were calculated. The average improvement for all of the bales against the original bale data was $0.41 per bale. Comparatively in 2002, a total of 3,422,180 bales from 184 gins were identified and evaluated. The average bale-loan-value for module-averaged data compared to individual bale data was $0.42 per bale. Some data varied in cost benefit compared to other data in both years but overall, there was financial benefit using module averaging. Comparisons to the loan chart will vary by year and market volatility and, therefore, the results found for 2003 and 2002 may not reflect future years. For 2003, when comparing the classing office regions, the net gain against individual bale data values ranged from a low of $0.12 per bale to a high of $0.73 per bale. The total gain in 2003 represented by the module-averaged portion of the crop when compared to the individual bale data was over $1.52 million. The results for subsequent years could vary up or down depending upon many variables associated with the status of the cotton market and the loan schedule.

Conclusions

Since its inception in 1991, the module/trailer averaging program has been a successful method of reducing variability in the measurements of cotton fiber length, strength, length uniformity, and micronaire. Analysis comparing HVI results between classing laboratories and the Quality Assurance Branch since 1991 has shown that, without exception, the reproducibility is higher every year when module averaging micronaire, strength, length, and length uniformity over the traditional single-bale method of testing. The Cotton Program has always taken a proactive approach in implementing any method that could provide more reliable classification results to its customers. For that reason, it has continually strived to further implement the module average program. The program experienced a solid increase in participation with the 2003 season as the number of participating gins rose from 184 to 210, an increase of 14% over 2002. This was even more impressive when considering that in 2002, there were 904 active gins (20% participation in module averaging) and in 2003, there were 867 active gins (23% participation). In addition, the total number of bales increased from 3,422,180 in 2002 to 3,808,979 in 2003, an increase of 11%.

A previous lull in participation apparently resulted from a lack of understanding or confidence in the program. The primary part of module averaging receiving the most attention, skepticism, and in many cases support, is the handling of outlier bales. After years of data analysis and recommendations from different segments of the cotton industry, the Cotton Program implemented a policy change in 2002 whereby all qualifying middle-bale outliers automatically receive the module average resulting from averaging the module's bales after removal of outliers for re-calculation. The studies over the years proved that an overwhelming majority of the middle-bale outliers resulted from testing flaws or other anomalies unrelated to cotton variability and returned to the module average when retested. The industry response to the change was very positive with most skepticism and negative feedback coming from isolated sources. In 2003, the Cotton Program tightened the outlier identification tolerances due to improved testing accuracy obtained in recent years and the success of the 2002 policy change. These tolerances had remained unchanged for several years prior to 2003.

During cotton industry meetings in summer 2003, the subject of module averaging outliers was raised and a resolution proposed to the National Cotton Council to request that the Cotton Program discontinue its policy of automatically assigning the module average to middle-bale outliers. Upon consideration of the proposal, the Cotton Program decided to postpone any decision regarding changing the policy until after the 2003 classing season, which was already underway, and until which

time they could receive adequate feedback from affected industry segments. The Cotton Program sent a letter to the cotton industry indicating its intention to change the outlier policy to assign the original values to all outliers effective at the end of the 2003 season and pending further discussions with industry to gauge their feelings on the subject.

The Cotton Program will continue to analyze the crop's data each year to reaffirm the principals behind module averaging. Even though these have proven valid since the inception of module averaging, we owe it to all segments to ensure that the supporting data and statistics remain true. We remain convinced that the module averaging program is beneficial to all segments by better assuring that the data utilized in the marketing and processing chain is the most accurate possible.

References

Earnest, Darryl. 2003. Module Averaging – A New Perspective. Proceedings of the 2003 Beltwide Cotton Conferences, pp. 677-684.

Gibson, William. 2003. Futures Classification and Quality Assurance in USDA, AMS, Cotton Program. Proceedings of the 2003 Beltwide Cotton Conferences, pp. 673-676.

Table 1. Participation in Module/Trailer Average Program.

Crop Year	Number of Gins	Number of Module/Trailer Averaged Bales	Percentage of Crop
1992	212	2.3 million	15%
1993	242	3.1 million	20%
1994	304	4.4 million	24%
1995	251	3.7 million	22%
1996	229	3.8 million	21%
1997	198	3.6 million	20%
1998	173	2.4 million	18%
1999	174	3.0 million	19%
2000	188	3.4 million	21%
2001	186	3.7 million	19%
2002	184	3.4 million	20%
2003	210	3.8 million	23%
Average	**213**	**3.4 million**	**20%**

Table 2. HVI Reproducibility Tolerances.

HVI Reproducibility Tolerances			
Micronaire (units)	**Strength (grams/tex)**	**Length (inches)**	**Length Uniformity (percent)**
± 0.1	± 1.5	± 0.02	± 1.0

Table 3. 2003 Outlier Tolerances.

Outlier Tolerances			
Micronaire (units)	**Strength (grams/tex)**	**Length (inches)**	**Length Uniformity (percent)**
± 0.3	± 3.0	± 0.04	± 2.0

Table 4. Outlier Statistics.

Crop Year	Total Bales Module Averaged (MA)	Micronaire		Strength		Length		Length Uniformity	
		Outlier Bales	% of Total MA	Outlier Bales	% of Total MA	Outlier Bales	% of Total MA	Outlier Bales	% of Total MA
1994	4,086,938	43,549	1.07%	22,524	0.55%	6,852	0.17%	1,987	0.05%
1995	3,761,923	41,024	1.09%	30,008	0.80%	8,183	0.22%	2,213	0.06%
1996	3,824,237	49,892	1.30%	34,253	0.90%	8,282	0.22%	1,628	0.04%
1997	3,635,025	49,351	1.36%	29,898	0.82%	12,346	0.34%	2,140	0.06%
1998	2,443,411	32,184	1.32%	25,588	1.05%	8,267	0.34%	920	0.04%
1999	3,061,970	44,996	1.47%	43,439	1.42%	16,524	0.54%	1,490	0.05%
2000	3,430,372	29,461	0.86%	35,117	1.02%	9,434	0.28%	1,664	0.05%
2001	3,749,910	37,906	1.01%	37,696	1.01%	11,775	0.31%	1,032	0.03%
2002	3,422,180	10,279	0.30%	4,705	0.14%	2,873	0.08%	101	0.00%
2003	3,808,979	25,699	0.67%	10,925	0.29%	13,815	0.36%	2,661	0.07%

Table 5. Middle-Bale Outliers (QA Checklot Tests vs. Module Average Values from Classing Offices)

Middle Bale Outliers (Checklot Bales)
(QA Checklot Test vs. Module Average Values from Classing Office)

Quality Factor	Reproducibility (within new tolerances)		Reproducibility (within old tolerances)	
	2003 (950)	2002 (724)	2003 (505)	2002 (268)
Micronaire	81% (268)	81% (230)	82% (157)	83% (95)
Strength	99% (288)	96% (191)	99% (252)	96% (110)
Length	97% (304)	93% (239)	100% (80)	93% (61)
Length Uniformity	99% (90)	98% (64)	100% (16)	100% (2)

(##): Total number of outlier checklots in category

* Data through 12/26/03

New Outlier Tolerances:
Length +/- 0.04 inches
Micronaire: +/- 0.3 units
Strength: +/- 3.0 grams/tex
Length Uniformity: +/- 2.0%

Old Outlier Tolerances:
Length +/- 0.06 inches
Micronaire: +/- 0.4 units
Strength: +/- 3.3 grams/tex
Length Uniformity: +/- 3.0%

Table 6. First-and-Last-Bale Outliers (QA Checklot Tests vs. Module Average Values from Classing Offices)

First-and-Last Bale Outliers (Checklot Bales)
(QA Checklot Test vs. Module Average Values from Classing Office)

Quality Factor	Reproducibility (within new tolerances)		Reproducibility (within old tolerances)	
	2003 (552)	2002 (126)	2003 (349)	2002 (126)
Micronaire	51% (273)	39% (57)	49% (185)	46% (57)
Strength	90% (102)	83% (42)	88% (96)	86% (42)
Length	79% (148)	69% (26)	78% (64)	81% (26)
Length Uniformity	97% (29)	100% (1)	100% (4)	100% (1)

(##): **Total number of outlier checklots in category**

New Outlier Tolerances:
Length +/- 0.04 inches
Micronaire: +/- 0.3 units
Strength: +/- 3.0 grams/tex
Length Uniformity: +/- 2.0%

Old Outlier Tolerances:
Length +/- 0.06 inches
Micronaire: +/- 0.4 units
Strength: +/- 3.3 grams/tex
Length Uniformity: +/- 3.0%

* Data through 12/26/03

Table 7. Middle-Bale Outliers (QA Checklot Tests vs. Individual Single-Run Values from Classing Offices)

Middle Bale Outliers (Checklot Bales)
(QA Checklot Test vs. Individual Single-Run Values in Classing Office)

Quality Factor	Reproducibility (within new tolerances)		Reproducibility (within old tolerances)	
	2003 (950)	2002 (724)	2003 (505)	2002 (268)
Micronaire	39% (268)	38% (230)	39% (157)	21% (95)
Strength	29% (288)	26% (191)	37% (252)	25% (110)
Length	26% (304)	33% (239)	23% (80)	23% (61)
Length Uniformity	29% (90)	41% (64)	50% (16)	0% (2)

(##): **Total number of outlier checklots in category**

New Outlier Tolerances:
Length +/- 0.04 inches
Micronaire: +/- 0.3 units
Strength: +/- 3.0 grams/tex
Length Uniformity: +/- 2.0%

Old Outlier Tolerances:
Length +/- 0.06 inches
Micronaire: +/- 0.4 units
Strength: +/- 3.3 grams/tex
Length Uniformity: +/- 3.0%

* Data through 12/26/03

Table 8. First-and-Last-Bale Outliers (QA Checklot Tests vs. Individual Single-Run Values from Classing Offices)

First-and-Last Bale Outliers (Checklot Bales)
(QA Checklot Test vs. Individual Single-Run Values in Classing Office)

Quality Factor	Reproducibility (within new tolerances)		Reproducibility (within old tolerances)	
	2003 (552)	2002 (126)	2003 (349)	2002 (126)
Micronaire	69% (273)	67% (57)	74% (185)	72% (57)
Strength	31% (102)	38% (42)	34% (96)	43% (42)
Length	50% (148)	31% (26)	54% (64)	58% (26)
Length Uniformity	62% (29)	0% (1)	100% (4)	100% (1)

(##): **Total number of outlier checklots in category**

* Data through 12/26/03

New Outlier Tolerances:
Length +/- 0.04 inches
Micronaire: +/- 0.3 units
Strength: +/- 3.0 grams/tex
Length Uniformity: +/- 2.0%

Old Outlier Tolerances:
Length +/- 0.06 inches
Micronaire: +/- 0.4 units
Strength: +/- 3.3 grams/tex
Length Uniformity: +/- 3.0%
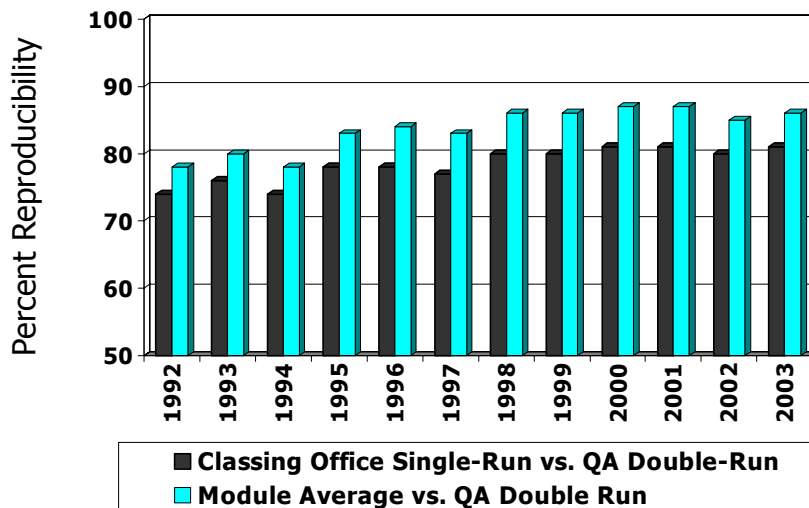
Figure 1. Reproducibility of Micronaire 1992-2003.
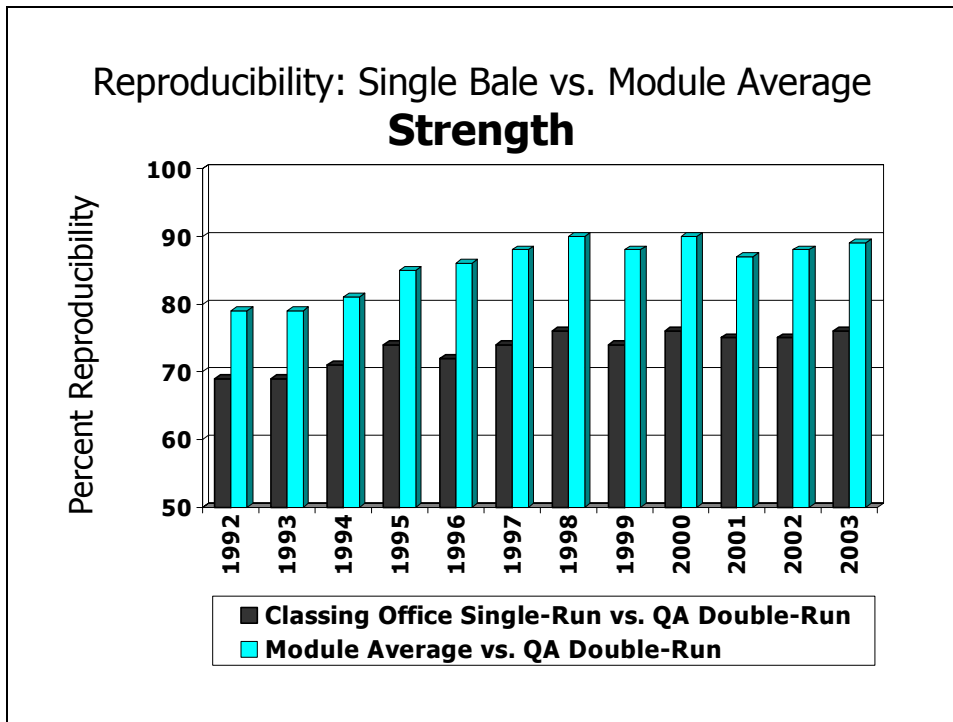
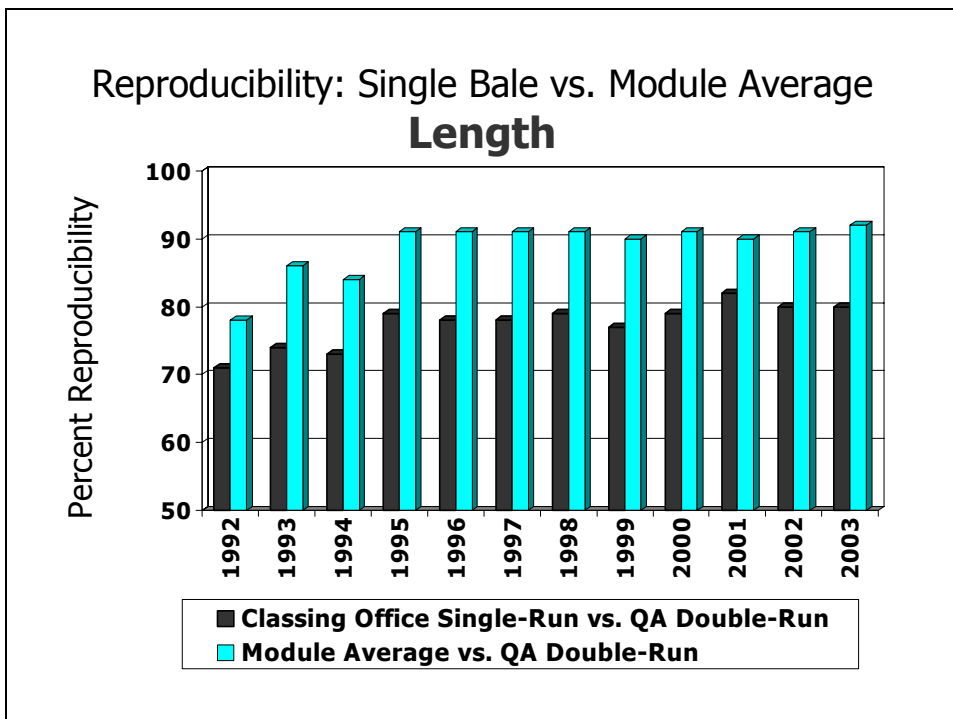Figure 2. Reproducibility of Strength 1992-2003.

Figure 3. Reproducibility of Length 1992-2003.
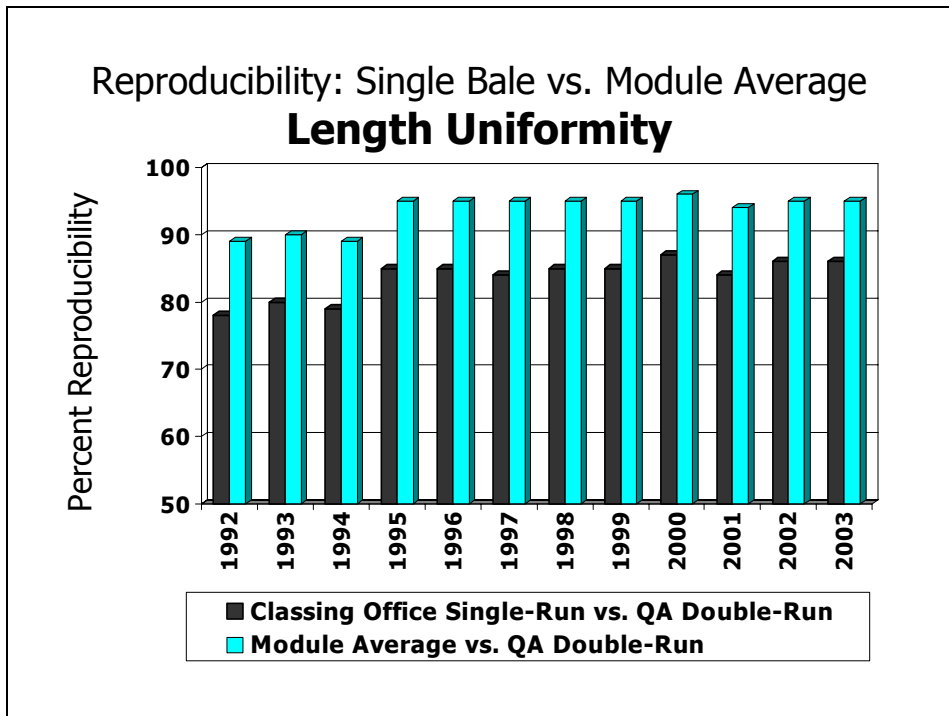
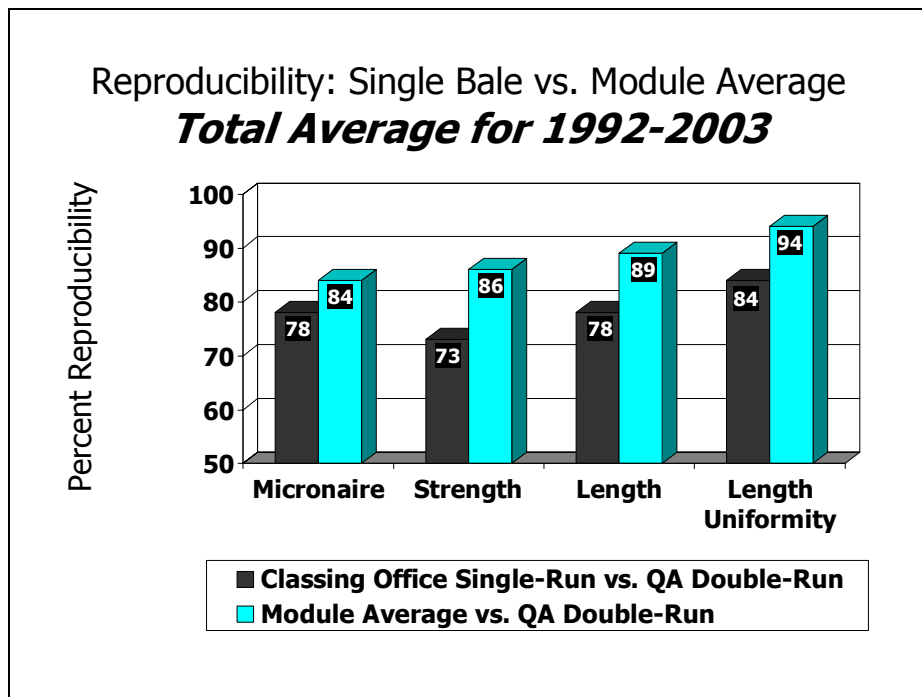Figure 4. Reproducibility of Length Uniformity 1992-2003.

Figure 5. Total Average Reproducibility of Four Factors 1992-2003.
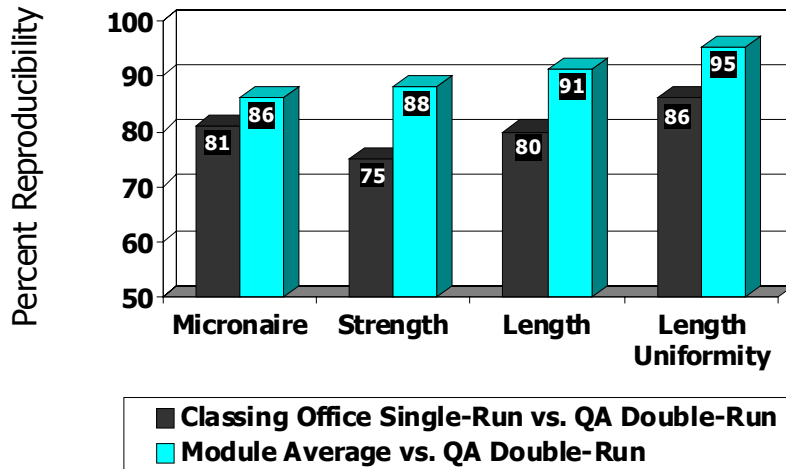
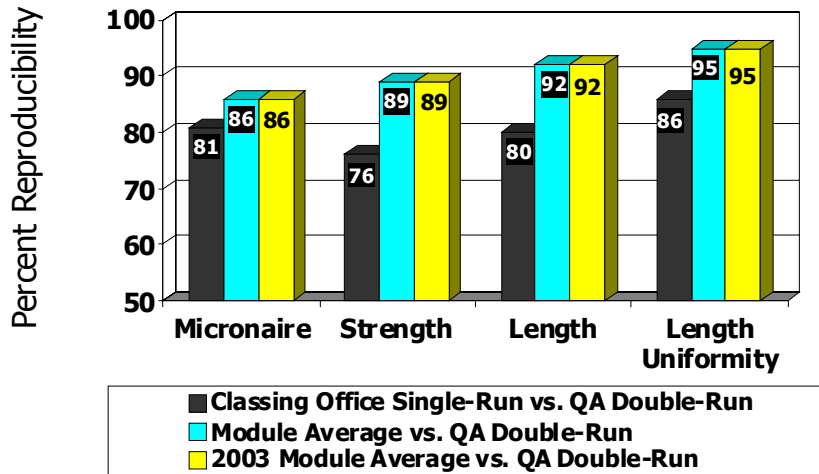Figure 6. Total Average Reproducibility of Four Factors 1999-2003.

Figure 7. Total Average Reproducibility of Four Factors – 2003 crop.